A Mathematical Model for Estimating the Quality of Service of Mobile Cellular Network Provider in Nigeria

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Abstract: The liberalization of telecommunication sector in Nigeria led to serious competition among the cellular mobile network service providers. In spite of the big financial commitment by these companies into their particular communication technologies, users ultimately make purchasing decisions based on their identified quality of service (QoS). To meet the expectation of subscribers on quality service delivery and gain a sustainable competitive edge in the market, network providers have to understand and characterize customer's view of the quality of service provided by their given technologies. In this study, the factors that influence the quality of service of mobile network operators in Nigeria were assessed through a cross-sectional survey design. A total of 100 experts from telecommunication industry and 300 subscribers of the four major network operators (MTN, Glo, Airtel, 9 Mobile) aged between 18 and 65 years living in the South East (Imo State, Ebonyi State, Anambra State, Abia State and Enugu State) of Nigeria were enrolled into the study using a random sampling technique. The quantitative approach used was regression analysis. In order to manage the large volume of data gathered, statistical package for social sciences [SPSS] software window version 18.0 was employed. It was observed that the factors that influence the quality of service of mobile cellular network providers in Nigeria are: Customer care ($L2$), Network coverage/ Availability of service ($L5$), Price of service ($L4$), Call quality ($L3$), Diversity of bundle option of service ($L1$) and Promotion/Offering of Incentive ($L6$). When considered together, all the factors significantly affect the quality of services of the mobile network service provider with 0.000 significant level of confidence. A model of the relationship between the Quality of service (dependent variable) and the Quality of service factors (independent variables) was derived as: $Y=3.731 + 0.565L5 + 0.440L3 + 0.221L2 + 0.189L4 + 0.165L1 + 0.097L6$. It is suggested that telecommunication industries invest more on radio infrastructural development to guarantee a very wide coverage area and boost Call quality.

Keywords: Quality of Service, Mobile Cellular Network, Relationship Model, Quality of Service Factors

1. Introduction

In the year 2000, cellular telecommunication networks caused an important revolution in Nigeria by allowing quick and easy communication between parties. At that time, very basic services (like voice call and SMS messaging) were supported and service requirements were not an issue. However, one of the most significant achievements recorded along the years has been the support for a richer variety of services and a higher level of service personalization. The different nature of the services implies explicit quality necessities that require to be achieved so as to satisfy the end-user expectations [1]. Unfortunately for mobile network service providers in Nigeria, loyalty is a rare trait among customers (an average mobile phone user patronizes two or more network service provider) whose purchasing decision is based on the perceived quality of service (QoS) [2, 3]. Certainly, a company most important success factor is its

ability to deliver better customer value than the competitors. As cellular technology continues to ingrain itself in every area of society, it is pertinent that network providers understand and characterize customer's view of the quality of service provided by their given technologies in order to have a sustainable competitive edge in the market.

The increasing support for a richer variety of service and service requirement witnessed over years in the telecommunication industry has stimulated diverse research interest in the Quality of Service (QoS) of cellular mobile network providers in Nigeria. Several studies have been carried out in this area each isolating the individual quality of service factors and the impact on the quality of service. However, this is not objective enough as it fails to give insight on the collective effect of the combine factors on quality of service. This issue is addressed in the current work.

1.1. Objectives of Study

The broad objective of the study is to establish a relationship model between quality of service of mobile cellular provider and the quality of service factors. The specific objectives include:

   i. Identification of factors influencing quality of service of cellular mobile network.
   ii. Assessing collective effect of these factors on quality of service of mobile network.

1.2. Research Questions

In line with the statement of problem and objectives of the study, the researcher asked the following questions:

   i. What are the factors influencing quality of service?
   ii. To what degree do all the factors collectively influence quality of service?

The answer to these questions will be provided based on facts and figures gathered in the course of this research.

1.3. Statement of Hypothesis

On the basis of the statement of problem, objective and research questions of the study, the researcher also formulated the hypothesis to be tested:

Ho1 There is no significant impact of the collective factors on quality of service.

1.4. Significance of Study

The findings of this paper will be of immense benefit to the telecommunication regulatory body, subscribers and network operators in Nigeria telecommunication industry. This research will help the Nigeria Communication Commission in the fight to protect ICT consumer's interests by providing a clear means of estimating the quality of service of cellular network operators to ensure that they satisfy the minimum standard requirement as contain in the Quality of Service regulations. The study is also relevant to the Network operators in Nigeria as it will expose them to the critical quality of service factors that need to be closely monitored in order to deliver value to the customers and

subsequently boost the customer's base. It will also assist over 188.2 million telecom subscribers in Nigeria to make an informed decision when choosing the service of a given cellular network provider. The research work contributed to the body of knowledge and serve as a reference point for other researchers in the field of telecommunication by providing an insight in the relationship between quality of service and the factors affecting the quality of service of mobile cellular service provider in Nigeria.

2. Literature Review

2.1. Research Frameworks

Theories related to this research work are: the Customer's Satisfaction Model and Four-Layered Quality of Service (QoS) Model. The four-layered Quality of Service (QoS) model is shown in Figure 1. It is base on the architecture proposed by 47 ITU-T and has relationship with other theories such as the OSI reference model and the theory of Quality of Experience (QoE). Quality of Service paradigm in network starts with discovering client's expectations from the service providers, or specifically from the basic network they are using. These expectations aid service providers in defining the network performance parameters, end-to-end delay, delay variation or jitter, information loss, throughput and the like [4].

There is a range of mechanisms available for application to different network layers in order to obtain the values identified for these parameters. The end part of the model deals with the customer's experience with regards to network performance, linking the model to Quality of Experience (QoE).

Each network layer uses its own mechanisms to attain certain Quality of Service levels base on the key performance parameters. Physical layer employs adaptive modulation together with coding scheme to enhance the interference management and bandwidth allocation base on the network conditions. To enhance the parameters of Quality of service; network layer utilizes queuing algorithms, path and access selection. The mechanism for sustaining the Quality of Service within the transport and application layer comprises of compression techniques and coding schemes. Connection management mechanisms are applied to help secure the Quality of Service at the application-level up to a reasonable level. Admission control algorithm regulates the maximum number of users in the network so as to maintain the least level of Quality of Service necessary to support the current transmissions. For example, a new user will not be admitted into the network if it will cause the interference level to rise to a value higher than the threshold. These mechanisms are aimed at achieving precision, timeliness and accuracy of transmission.

Also, customer's satisfaction model is relevant to this research work. There are many variables and factors determinants of Service quality base on this model. Reference [5] used these attributes and dimension as a

standard in the research carried out on mobile service. The Communication aspect of Customer Satisfaction depends on the network coverage, Call Drop Rate and Call Quality. Inside each cell of the mobile network, there are mainly two classes of call traffic: new call and handover call. A new call is the one which is generated in the current cell, while a handover call originated in another cell but transferred into the current cell. In order to start a communication with a base station, a mobile station has to first obtain a channel from the base station.
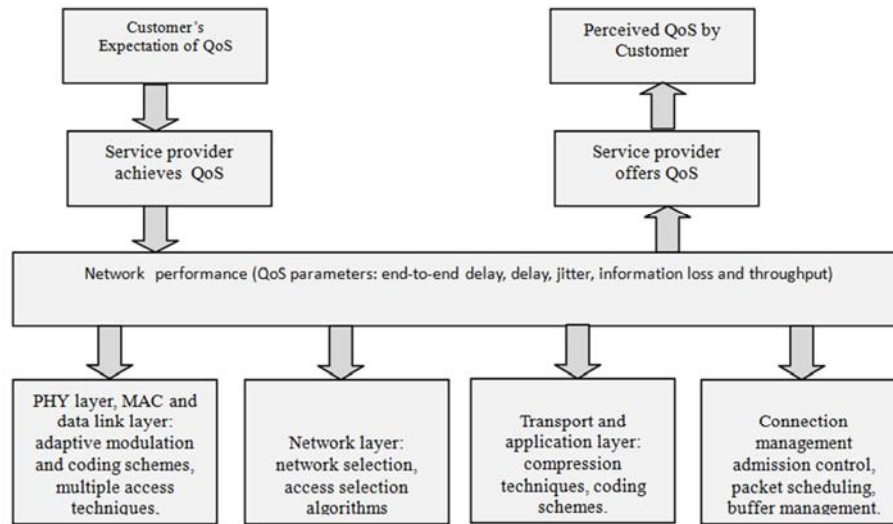

Figure 1. Four-layer QoS Model. Source: Farnaz Farid, Seyed Shahrestani, and Chun Raun (2013).
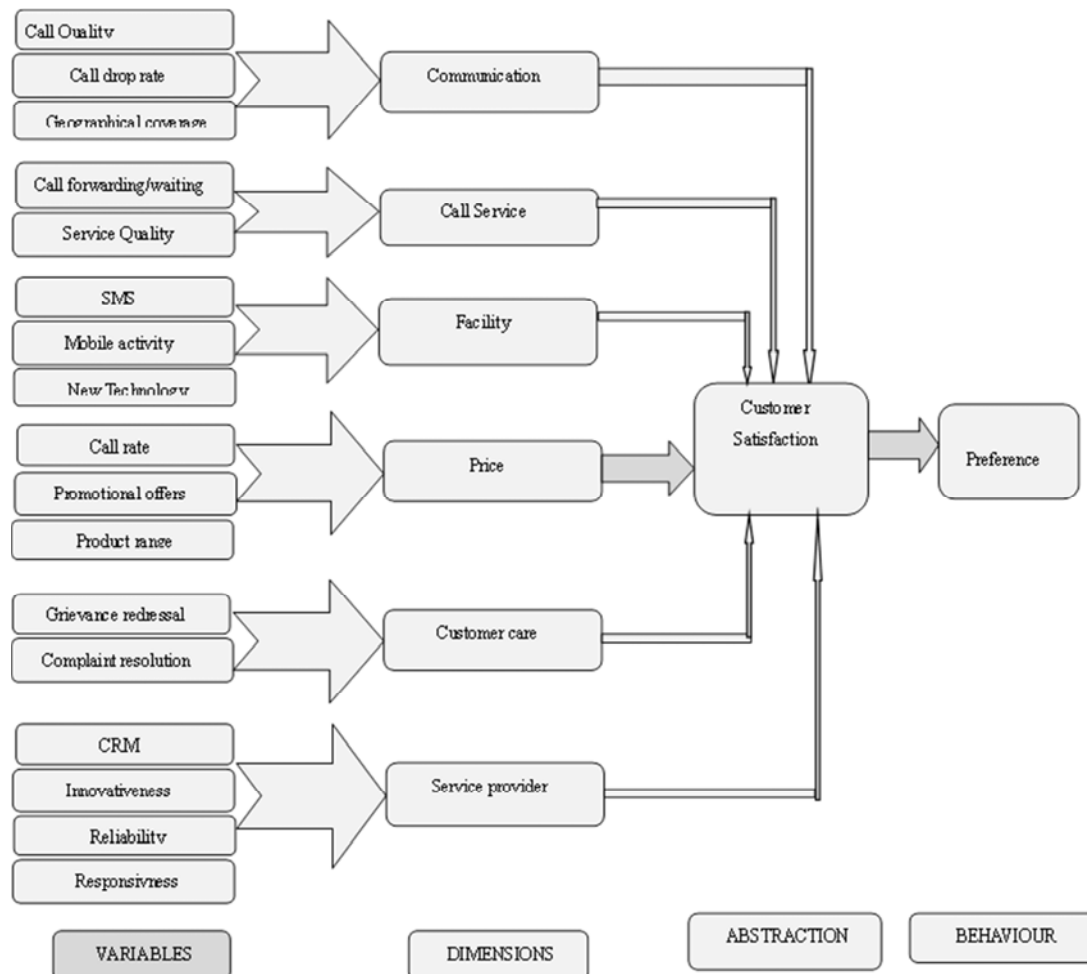

Figure 2. Customer's Satisfaction Model. Source: Rajesh, K. Y and Nishant, D. (2013).

When a call enters into the radio coverage of current cell, the channel allocation scheme decides whether the attempt of this call can obtain an available channel or not. If not, the call is rejected immediately. The handover process is often initiated either by crossing a cell boundary or by a deteriorated quality of received signal on the currently employed channel [7]. Calls are drop when attempt for call handover fail. If two cells using the same channel or same set of channels are not effectively spaced apart, co-channel interference could result and this affect call clarity.

Another variable known within the model is Network coverage/Availability of service. Cellular network subscribers are increasingly becoming mobile and as such would prefer mobility in terms of product and services. When the geographical coverage area of a given cellular mobile network provider is small, some of the customers who travelled outside the coverage region will be denied service, this affect the degree of customers satisfaction. According to Okeke [8], the customer's evaluation of quality is related to the availability of the salient futures of product/service in comparison with the competitor.

2.1.1. Factors That Affect the Quality of Service of Mobile Cellular Network Operators in Nigeria

The study assesses the factors influencing the Quality of Service of mobile network providers. The major variables identified are: Diversity of Bundle Option of Service, Customer Care, Call Quality, Price of Service, Network Coverage and Availability of Service, Promotion/Offering of incentive.

Network coverage/ Availability of product and Service: This refers to the area where the radio signals of a particular cellular network service provider can be received in addition to the accessibility of the services/products requested by users [7]. Although there is moderate network coverage in the cities, the network capacity of the various cellular network providers in Nigeria is still inadequate. Provision of strong reliable and non-fluctuating signals all over the country will boost the customer's perceived quality of service [9].

Price of service: Products and Services are expected to compete on both quality and price in a competitive market. Price of service is the sum of money required to purchase a product or service [10]. It covers SMS charge, call rate, price of recharge vouchers and data charge [9]. In recent time, the competition in telecommunication sector has compelled the cellular mobile network service operators to provide innovative services at a fair price in a bid to attract and sustain customers [2].

Promotion/Offering of incentive: This refers to the advertising process and material inducement aimed at making products/services of the cellular mobile network operator widely popular and acceptable by the subscribers in a given locality [9]. It involves every effort employed by a company to educate, enlighten, convince or remind both customers and the general public of new and existing products [10]. According to Ndubuisi and Moi [11] and Reena [12], Nigerian telecommunication consumers respond positively to freebies like free samples, bonus packs, price discounts etc.

Diversity of bundle option of service (Market Segmentation): This is the process of dividing a market into units and locating individuals who belong to each market. When the focus of market segmentation is on the principle of consumption type, customers have the privilege of choosing from the available range of service/Product, the service plan which best satisfy their expectation at any particular time.

Customer care: Customers service is a system of activities that involves customer support systems, complaint processing, speed of complaint processing, ease of reporting complaint and friendliness when reporting complaint [13, 14]. It centers on the ability of the cellular mobile network operators to handle satisfactorily and timely customer's complaint. Therefore, customer service include all help and assistance network providers render to customer directly or indirectly prior to, during, and after purchase to provide exciting customer experience with their product and services [9].

Call Quality: This is associated with the clarity of call, call blocking and dropping rate. When two cells using one channel or same set of channels are not effectively spaced apart, co-channel interference could result to noise which adversely affects call clarity. In a cellular mobile network, call service is one of the major products of interest to the consumers; hence, Call quality has a direct impact on the quality of service [8].

2.1.2. Conceptual Framework

Research framework is a framework that builds from a combination of wide range of ideas and theories and helps studies identify problems, develop questions and search for relevant literature [15]. The conceptual model of this paper is shown in figure 3. The model included seven variables, six of which are independent (Diversity of Bundle Option of Service, Customer Care, Call Quality, Price of Service, Network Coverage and Availability of Service, Promotion/Offering of Incentive.) and one dependent, namely Quality of Service. Conceivably, these six variables affect the Quality of Service of cellular mobile network operator as has been presented in the hypotheses developed.

The first four constructs (Price, Network coverage /Availability of Service, Call Quality, Promotion and Offering of incentive) where confirmed in similar study carried out by Okeke [8] whereas the last two; Market segmentation and customer care were employed by Rajkumar et al. [16]. It is expected that this research will put the correlation between Quality of service and the factors above.
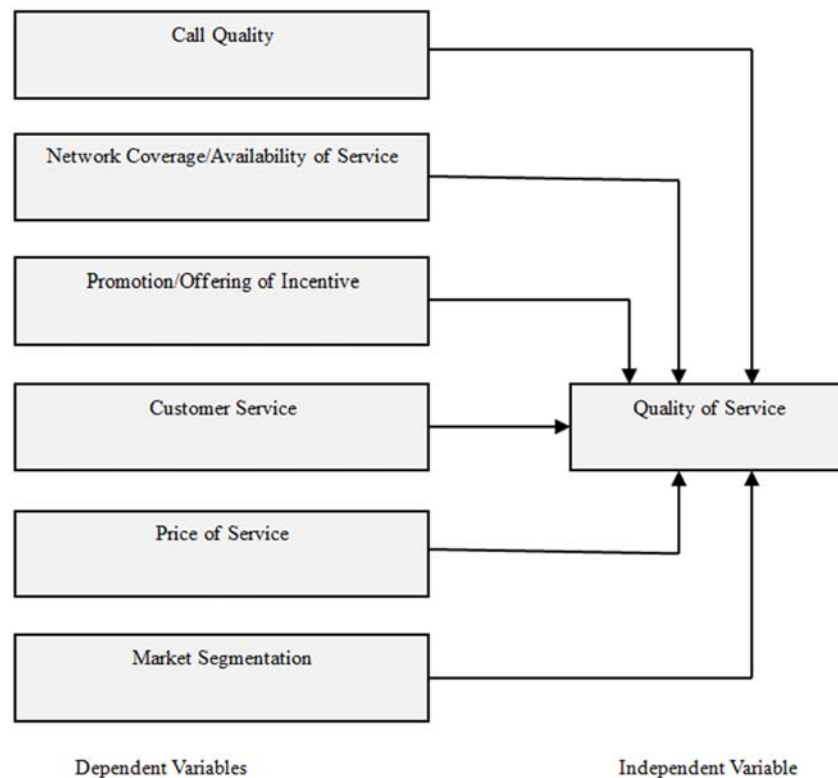
Figure 3. Conceptual Framework.

2.2. Contribution of Related Works and Research Gap

A significant amount of research has been carried out to assess the factors that affect the Quality of Service of mobile network service providers. Reference [17] proposed a QoS assessment methodology for mobile cellular communication networks centered on the data gathered through drive-testing. The study centered on the end user view of service quality by providing autonomous QoS measurement for both voice and data services. The authors discussed QoS assessment for circuit and packet switched network but fail to present QoS measurements in relation to both voice and data service at the same time.

Also, In Canada, the consumers' satisfaction survey in 2007 based on the responses of 6,000 mobile phone users indicated the essential elements of service quality of mobile operators as call quality, prices, customers' services, and Market segmentation [6].

Reference [2] carried out a research which showed that in Nigeria, mobile network provider's attention has progressively shifted from expanding the network coverage area to Market segmentation since limited service option could result to dissatisfaction which adversely affect the customer's perceived quality of service. Reference [18] study on Quality of service and Customers preference revealed that Call quality, availability of service and Price have the greatest influence and are given preference in choosing the service of a mobile network provider. However, the impact of the individual Quality of service factors on Quality of service was studied in isolation.

From the literature reviewed, it is quite obvious that there is need for the development of a user-centric assessment approach that gives an objective measurement of the Quality of service of mobile network service providers. The aim of this research work is to provide solution to this challenge.

3. Research Methodology

This research was conducted using quantitative approach. The main source of data used in the work was questionnaire while the secondary sources of data include data from several ICT related sites like the International Telecommunication Union (ITU), Nigerian Communications Commission (NCC), Globacom, MTN-Nigeria, Airtel, 9 mobile and data from the researchers in related topical issues. The questionnaire consisted of 3 sections: Section A is for the experts (employee of the four key telecommunication companies mentioned above), Section B is for the subscribers only, while Section C is for both categories. Section A and Section B extracted respondents' demographic characteristics such as gender, age, occupation, educational qualification, etc. Section C include questions asked to find out both the expert's and the subscriber's view of the factors influencing quality of service of cellular mobile network providers in Nigeria. To obtain the sample size of the targeted population, Yamani's formula (1967) expressed as;

$$n = N/1 + N(e)^2$$

was used. Where "n" represent the sample size, "N" is the size of population (the number of Telecom subscribers in Nigeria), and "e" is the allowable error (0.05). The data from the Nigerian Communication Commission revealed that the total number of active telecom subscribers in 2021 is 188.8 million [19]. Applying these values to the equation, the sample size is calculated as; $n=188,824,496/1+188,824,496(0.05)^2=400$.

In all, 400 questionnaires were given out; 300 were distributed to subscribers while 100 went to the experts. A total of 293 (73.3%) copies were retrieved and used for the analysis. The variables used to assess the influencing factors (Network Coverage and Availability of Service, Customer Care, Call Quality and Call Drop Rate, Diversity of Bundle Option of Service, Price of Service and Promotion/Offering of Incentive) using the 5-point Likert scale were coded as: Strongly Disagree (SD)-1, Disagree (D)-2, Neither Agree nor Disagree (N)-3, Agree (A)-4 and Strongly Agree (SA)-5. Data gathered were subjected to multiple regression analysis using the SPSS (Statistical package for Social Sciences) software. The model describing the relationship is expressed as

$$Y=b_o+b_1L_1+b_2L_2+b_3L_3+b_4L_4+b_5L_5+b_6L_6+e \qquad (1)$$

Where L1 is Diversity of Bundle Option of Service, L2 is Customer Care, L3 is Call Quality and Call Dropping Rate, L4 is Price of Service, L5 is Network Coverage and Availability of Service, L6 is Promotion/Offering of Incentive.

4. Model Estimation and Hypothesis Testing

4.1. Relationship and Interpretation

The output obtained after subjecting the data collected to multiple regression analysis is shown in the tables below:

Table 1. Quality of Service (Y) and its independent Variable correlation (Source SPSS Analysis of Field Survey 2021).

		Y	X1	X2	X3	X4
	Y	1.000	.187	.127	.299	.217
	L1	.187	1.000	.218	.151	.092
	L2	.127	.218	1.000	.069	-.146
Pearson Correlation	L3	.299	.151	.069	1.000	.211
	L4	.217	.092	-.146	.211	1.000
	L5	.360	.182	.124	.199	.286
	L6	.080	.042	-.054	.026	.030
	Y	.	.001	.015	.000	.000
	L1	.001	.	.000	.005	.058
	L2	.015	.000	.	.119	.006
Sig. (1-tailed)	L3	.000	.005	.119	.	.000
	L4	.000	.058	.006	.000	.
	L5	.000	.001	.017	.000	.000
	L6	.085	.238	.179	.326	.303

Table 2. Quality of Service (Y) Model Summary (a. Predictors: (Constant), L6, L3, L2, L5, L1, L4), (Source SPSS Analysis of Field Survey 2021).

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				Change Statistics
					R Square Change	F Change	df1	df2	Sig. F Change
1	.456[a]	.208	.192	3.64050	.208	12.531	6	286	0.000

Table 3. Quality of Service (Y) and its independent Variables (a. Dependent Variable: Quality of Seervice) (Source SPSS Analysis of Field Survey 2021).

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	(Constant)	3.731	2.689		1.388	.166
	L1	.165	.116	.078	1.419	.157
	L2	.221	.150	.082	1.469	.143
1	L3	.440	.117	.206	3.753	.000
	L4	.189	.106	.102	1.788	.075
	L5	.565	.122	.263	4.636	.000
	L6	.097	.086	.059	1.120	.264

Model		95.0% Confidence Interval for B		Correlations		
		Lower Bound	Upper Bound	Zero-order	Partial	Part
	(Constant)	-1.561	9.023			
	L1	-.064	.394	.187	.084	.075
	L2	-.075	.516	.127	.087	.077
1	L3	.209	.670	.299	.217	.198
	L4	-.019	.398	.217	.105	.094
	L5	.325	.805	.360	.264	.244
	L6	-.073	.267	.080	.066	.059

Table 4. *ANOVA for Quality of Service (a. Dependent Variable: Quality of Service; b. Predictors: (constant): Network Coverage and Availability of ServiceL5, Call Quality L3, Price of ServiceL4, Customer Care L2, Market Segmentation L1 and Promotion/Offering of incentive L6) (Source SPSS Analysis of Field Survey 2021).*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	996.432	6	166.072	12.531	.000a
	Residual	3790.435	286	13.253		
	Total	4786.867	292			

A close look at the standardized Beta values in Table 3 shows that the largest coefficient (0.565) is contributed by the Network coverage/availability of service, followed by Call Quality (0.440), then Customer care (0.221), Price of Service (0.189), Diversity of bundle option of service (0.165) and Promotion / offering of incentive (0.097). Substituting these values into the relationship model (equation (1)), gives-

$$Y=3.731+0.565L5+0.440L3+0.221L2+0.189L4+0.165L1+0.097L6 \qquad (2)$$

Where Y is Quality of service of cellular mobile network operators, L5 is Network coverage/ Availability of service, L4 is Price of service, L3 is Call quality, L2 is Customer care, L1 is Diversity of bundle option of service, L6 is Promotion and offering of incentive.

The regression model above show that Quality of service reduces (increases) by 0.565 for every one measure decrease or increase in Network Coverage/Availability of Service, Quality of service reduces (increases) by 0.44 for every one measure decrease or increase in Call Quality, Quality of service reduces (increases) by 0.221 for every one measure decrease or increase in Customer Care, Quality of service reduces (increases) by 0.189 for every one measure decrease or increase in Price of Service, Quality of service reduces (increases) by 0.165 for every one measure decrease or increase in Diversity of bundle option of service and Quality of service reduces (increases) by 0.097 for every one measure decrease or increase in Promotion and offering of incentive.

The t-test analysis (Table 3), shows that Network coverage/Availability of service and Call Quality were the only significant factors that affect the Quality of Service while other factors (that is Price of service, Customer care, Diversity of bundle option of service and Promotion/offering of incentive) were observed to be insignificant when considering their individual effect on the Quality of Service.

From Table 2, the coefficient of correlation (0.456) indicates that 45.6% correlation exists between the Quality of Services of cellular mobile network providers (dependent variable) and the factors affecting Quality of Service (independent variable). This relationship is considered a significant predictor of the cellular mobile network providers Quality of Service base on the sig. F- change value of 0.000 (Table 4) which is less than 5% level of confidence.

Also, the R-Square value of 0.208 (Table 2) shows that 20.8% of the variation in the Quality of Service of cellular mobile network provider in Nigeria is explained by the cumulative variations in the six independent variables; when all possible error in the estimation is taken into consideration.

4.2. Hypothesis Testing

The formulated hypothesis was tested using Table 3, Table 2 and Table 4 at 0.05 level of confidence:

H01: There is no significant effect of the collective factors on the Quality of Service.

HA1: There is a significant effect of the collective factors on the Quality of Service.

In order to test the null hypothesis H0 stated above, we consider the analysis of variance (ANOVA) based on F-Test (table 4). The model reaches statistical significance at (sig=.000) which is less than the significance level of 5% ($p<0.05$). Therefore, we reject the null hypothesis H0 and accept the alternative hypothesis HA which states that there is a significant effect of the collective factors on the Quality of Service.

4.3. Result and Discussion

The study on the quality of service (QoS) of cellular mobile network operator in Nigeria provided an insight on the relationship between QoS and the various QoS factors for the benefit of the key players in the telecommunication industry.

Quality of Service (Y)

From Table 1 correlations of independent variables (L) and Quality of service (Y), Network coverage (L5) shows the highest correlation figure of 0.360 (36.0%) compared to other variables and the dependent variable, followed by Call Quality (L3) 0.299 (29.9%), Price of Service (L4) 0.217 (21.7%), Market segmentation (L1) 0.187 (18.7%), Customer Care (L2) and Promotion /Offering of incentive (L6) 0.080 (8.0%).

The results of this research agree with Nwakanma et al. [9] who revealed that the quality of service and subscriber's decision to port among network providers is mostly related to the availability of products main functional features (source of the primary benefits that the consumer expect to obtain when purchasing the product) on one hand and a consumer's experience-in –use of the auxiliary features on the other. This implies that any effort made to expand the coverage area of network and bring product/service to the reach of customers will greatly enhance the Quality of Service than when channeled to other areas.

Also, the research carried out by Gajanan and Deshmukh [20] showed that quality of service of mobile network is greatly affected by call quality. According to the study, poor call quality could lead to frustration which adversely affect user's perceived quality of service. This is also supported by

Dahunsi and Kolawole[21].

Table 3, is Quality of Service model summary which shows the relationship of the independent variables at R-value of 0.456 (45.6%), R Square-value of 0.208 (20.8) and Adjusted R Square-value of 0.192 (19.2) indicates that the variables as a whole accounted for 45.6% changes and significance on Quality of Service while the remaining percentage is measured by other factors not discussed in this work. Table 4 ANOVA for Quality of Service shows the significance of the model as a whole at a p-value $0.000 < 0.05$ error allowed. It indicated that when considered together, all the independent variables have a significant effect on the Quality of service of mobile cellular network providers in Nigeria which support the result of the research by Asiegbu et al. [7].

5. Conclusion and Recommendation

This research explored the impact of identified Quality of service factors on the Quality of Service of cellular mobile network providers in Nigeria and established a relationship model between the two variables. In addition, it ascertain the perception of both the subscribers and experts in the telecommunication sector on what factor, most significantly affect the Quality of Service of cellular mobile network operators in Nigeria. The results arrived at showed that the following factors affect the Quality of Service: Network coverage/ Availability of product and Service, Call quality, Customer care, Price of service, Diversity of bundle option of service and Promotion/Offering of incentive. Though the six factors above affected the Quality of Service collectively, it was also discovered that two factors namely Network coverage/Availability of service or product and Call quality were more significant going by the results of the t-test while Diversity of bundle option of service and Promotion/offering of incentive as Quality of Service factors have the least impact on the Quality of Service. Finally, the model $Y = 3.731 + 0.565L5 + 0.440L3 + 0.221L2 + 0.189L4 + 0.165L1 + 0.097L6$ was establish for estimating the quality of service of cellular mobile network operators in Nigeria. Where Y represents the Quality of service of cellular mobile network operators, L5 is Network coverage/ Availability of service, L3 is Call quality, L4 is Price of service, L2 is Customer care and L1 is Diversity of bundle option of service and L6 is Promotion and offering of incentive.

It is recommended that telecommunication industries invest more on radio infrastructural development to ensure a very wide coverage area and enhance Call quality. Further research work need to be carried out in this area to determine other possible factors that affect the quality of service of mobile cellular network providers in Nigeria.

References

[1] Kang (2006) The hierarchical structure of service quality: Integration of technical and functional quality. Manage Sev Quality 16: 37-50.

[2] Adeleke, Aminu (2012) The determinants of customer loyalty in Nigeria's GSM market. Int J Business Social Sci 3: 209-222.

[3] Berry, Parasuraman (1991) Marketing Services: Competing Through Quality. New York: Free Press.

[4] Farnaz Farid, Seyed Shahrestani and Chun Ruan (2013) Quality of Service Concerns in Wireless and Cellular Networks. Communications of the IBIMA, Vol. 2013 (2013).

[5] Haque, A et al (2010) Factors Determinants the Choice of Mobile Service Providers: Structural Equation Modeling Approach on Bangladeshi Consumers. Business and Economics Research Journal 1 (3): 17-34.

[6] Rajesh, k. y and Nishant, D. (2013) Impact of Service Quality on Customer Satisfaction of Mobile Users. International Journal of Innovative Research and Studies 5 (2): 141-146.

[7] Asiegbu B. C., Ohuabunwa A. E., Nwakanma I. C., and Ezeh G. N. (2015) Assessment of the Factors affecting Quality of Service of Cellular Mobile Network Operators in Nigeria for the Period 2010 to 2014. International Journal of Engineering and Modern Technology 1 (2): 1-11.

[8] Okeke (2014) Factors Influencing the choice of GSM Network among oil and Gas Workers in Port Harcourt, Nigeria. Int J Emerging Knowledge 2: 8-22.

[9] Nwakanma IC, Udunwa AI, Anyiam KE, Ukwunna ED, Obasi EC, et al. (2018) Factors Influencing Telecommunication subscribers' decision to port among network providers in Nigeria. Am J Compt Sci Inform Technol Vol. 6 No. 1: 15.

[10] Kotler, Armstrong (2010) Principles of Marketing, 11 Edition. New York: Prentice Hall International.

[11] Ndubisi, Moi (2006) Customer behavioural responses to sales Promotion. The role of fear of losing face. Asia Pacific Journal of Marketing and Logistics 17: 32-49.

[12] Reena (2012) A study on factors Influencing brand loyalty in mobile service providers among college of business students of University Utara Malaysia. Thesis unpublished University Utara Malaysia.

[13] Kim, Park, Jeong (2004) The effects of customer satisfaction and switching barrier on customer loyalty in Korean mobile Telecommunication services. Electronics and Telecommunication Research Institute School of Business, Information and Communication University, Yusong-gu, Hwaan-dong, Taejon 305-348.

[14] Yoo, Park (2007) Perceived service quality: Analyzing relationship among employees, customers, and financial performance. Int J Quality & Reliability Management 24: 908-926.

[15] Smyth (2004) Exploring the usefulness of a conceptual framework as a research tool: A researcher's reflection Issues in Educational Research 14: 167-180.

[16] Rajkumar Paulrajan and Harish Rajkumar (2010) Service Quality and Customers Preference of Cellular Mobile Service Providers. The Journal of Technology Management & Innovation 6: 40-45.

[17] Kostanic, I., Mijatovic, N. and Vest, S. D. (2009) Measurement Based QoS Comparison of Cellular.

[18] Yadav et al (2013) Global Mobile Communication. New Delhi, Miley.

[19] Nigerian Communication Commission (2021) Active telecoms subscribers slide by 2.11% in April.

[20] Gajanan, P. U., and Deshmukh, C. N. (2013). QoS Based CAC Scheme for 3G Wireless Cellular Networks. A Review. International Journal of Computer Science and Applications, 6 (2), 181-185.

[21] Dahunsi, F. M., and Kolawole, G. (2015). Participatory analysis of cellular network quality ofservice. International Journal of Computing and ICT Research, 9 (1), 25-40.